

Carbon isotopes and CO₂ fixation

GRAHAM FARQUHAR

The Australian National University

Presenting Author: Graham.Farquhar@anu.edu.au

Photosynthesis entails uptake of carbon dioxide to make structures that we use for food, fuel and fibre, and liberates oxygen that we breathe for respiration, but (at least on land) requires a lot of water. This is because the cells inside a leaf are moist and whenever the stomatal pores in the leaf open to admit CO₂, they inevitably allow some water to be lost by evaporation. We ask the question how plants should control stomatal aperture to assimilate the greatest amount of CO₂ for a given total loss of water. Having identified theoretical differences in how plants should behave optimally in different environments, we ask how we can recognise such differences across genotypes. We show that carbon isotopic discrimination during assimilation enables us to do such phenotyping. We describe our collaboration with CSIRO in releasing wheat varieties selected initially on the basis of their discrimination, and identify a gene that plays a role in *Arabidopsis*. We give a brief introduction to the application of global measurements of carbon and oxygen isotopes in CO₂. We discuss the question of whether the substrate for Rubisco is gaseous CO₂ or dissolved CO₂ and describe recent modifications to the general equation for carbon isotope discrimination, related to the treatment of 'day' respiration. We examine the modelling of photosynthesis and photorespiration of C₃ plants at looming concentrations of CO₂.